



Towards Reliable Particle Number Testing of Defective Gasoline Particulate Filters During PTI

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Core Questions to Measure Gasolines During PTI

1 High-Emitter Detection

To what extent is high-emitter detection for gasoline vehicles currently achievable?
How does the measurement procedure have to look to reliably detect failed GPFs?

2 Key Parameters and Challenges

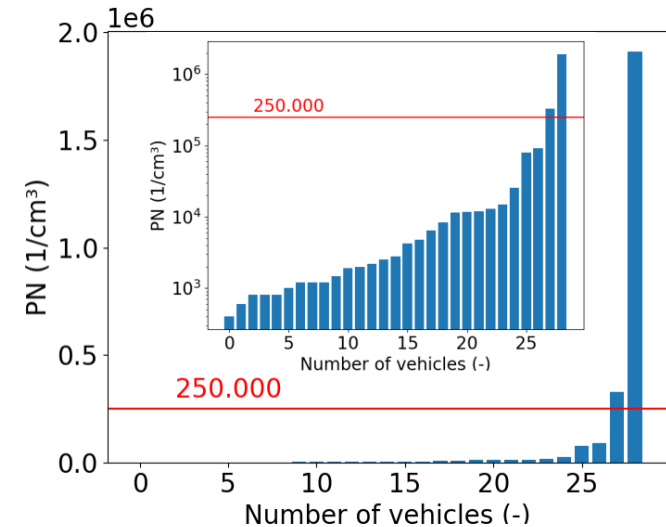
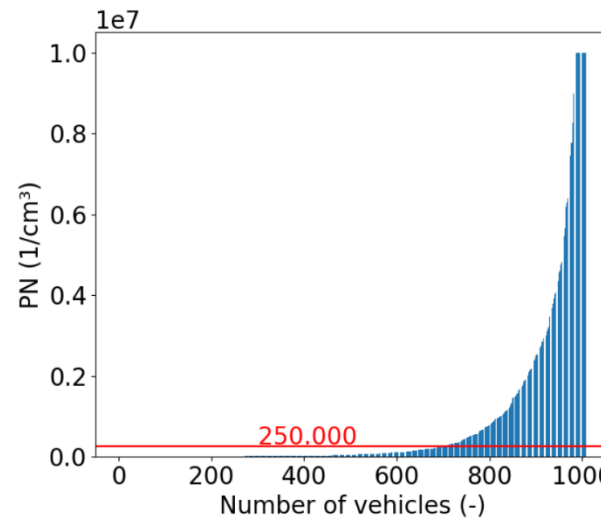
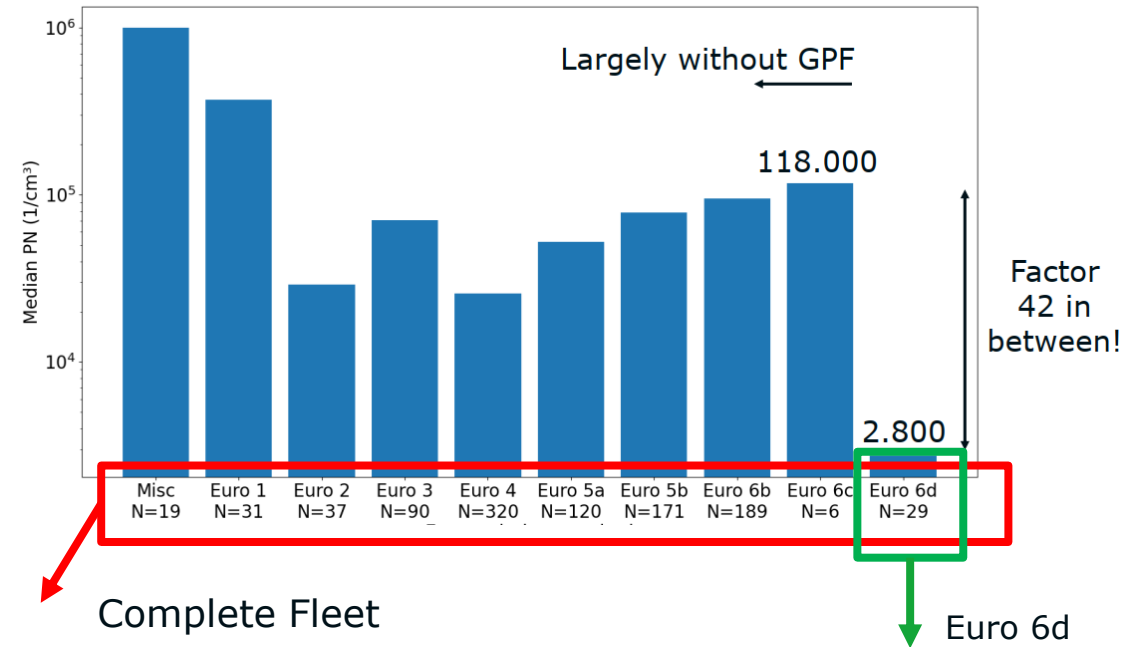
What are the differences between measuring diesel and gasoline vehicles?
What additional data is needed to ensure precise and reliable detection to lower false-pass and false-fail events?

3 10 nm-Cutoff

Does the introduction of a 10 nm-cutoff significantly improve detection performance for PTI?
Is a 10 nm limit for Euro 7 diesel vehicles feasible and beneficial for PTI ?

High Emitter Detection

- NPTI1000 campaign (Aerosolfd project)
 - High emitter detection was shown to be efficient for gasoline vehicles
 - Dirty Tail-paradigm holds up over complete emission fleet: overall and on newer cars
 - Sample size for Euro 6d too small to allow for significant statement
 - Euro 6d-temp: PN limit of $6 \cdot 10^{11}$
 - GPF requirement (GDI)
 - Relevant target vehicle class for PTI
- GPF detection possible, larger sample necessary for relevant vehicle class



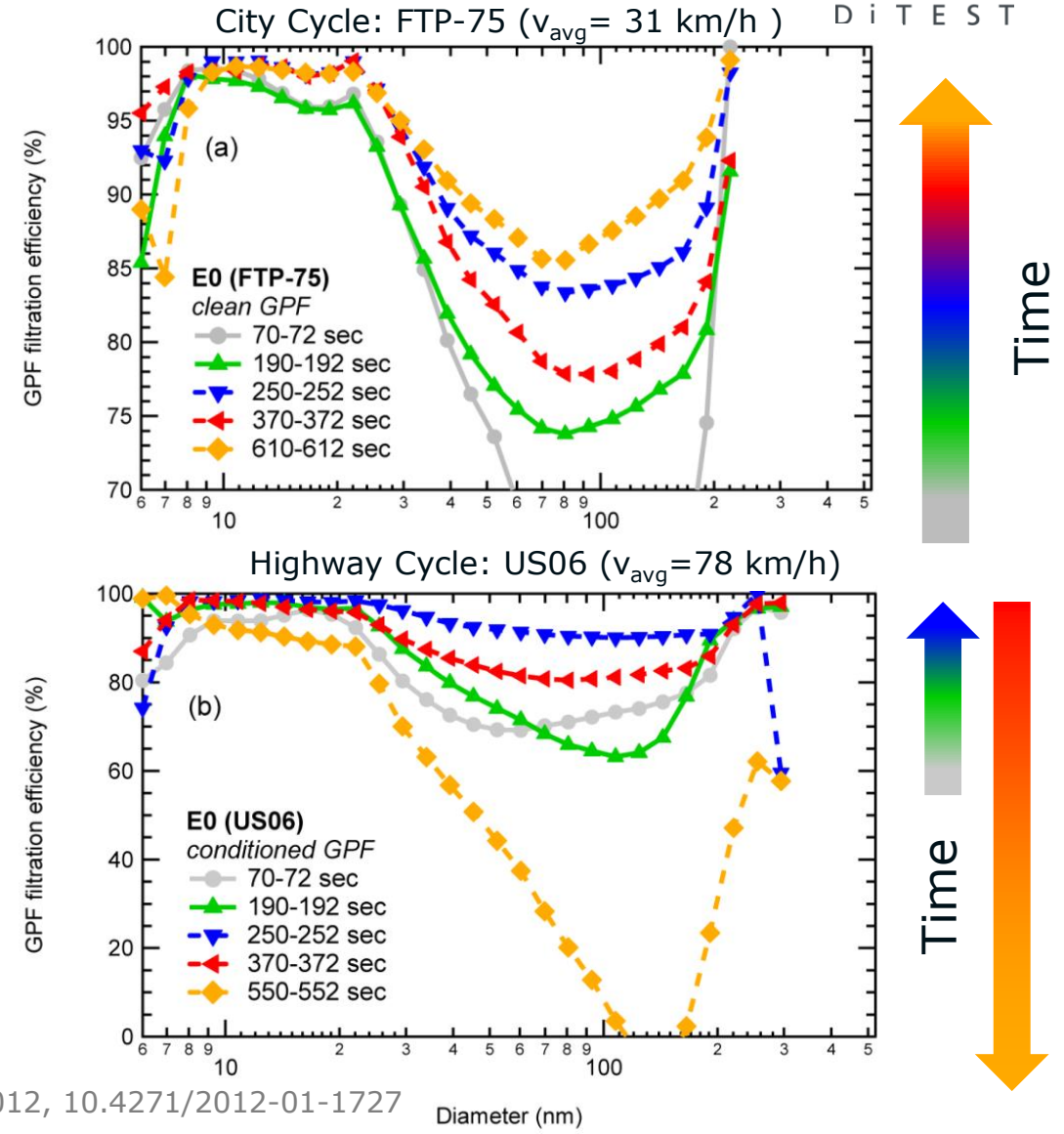
[1] Knoll et al, VERT Forum 2025

Key parameters for gasoline vehicles

- Particle Size Distribution
 - Gasolines emit smaller particles
 - Often bimodal distribution
- GPF: Different behavior compared to GPF
 - Increased passive regeneration
- Difference in generated PN emission
 - Strong dependency on vehicle load
 - Variability during idle measurements
- Increased Humidity
 - Higher risk of condensation
 - Possibly affects instrumentation
- Measurement procedure premises
 - Increased humidity, smaller particles
 - Reduced correlation idle \leftrightarrow homologation
 - Increased influence of vehicle load
 - Different circumstances influencing the measurement procedure and limit value
- Objective: Find procedure to assess GPF failure
 - **The goal is to correctly assess GPF, not to correlate to type approval results!**

Gasoline PTI – Particulate Filter

- Wall-flow filters forcing exhaust through porous walls to trap soot via diffusion/impaction/interception
 - **DPF:**
 - High soot loads and lower temperatures
 - Active regeneration required
 - Overall higher filtration efficiency
 - ~ 2 order of magnitude between states
 - **GPF:**
 - Higher exhaust temperatures, lower soot loading
 - Higher speed → further temperature increase
 - Passive regeneration triggered
- Does the different filtration behavior and efficiency influence the measurement procedure and limit values?



[2]Chan et al 2012, 10.4271/2012-01-1727

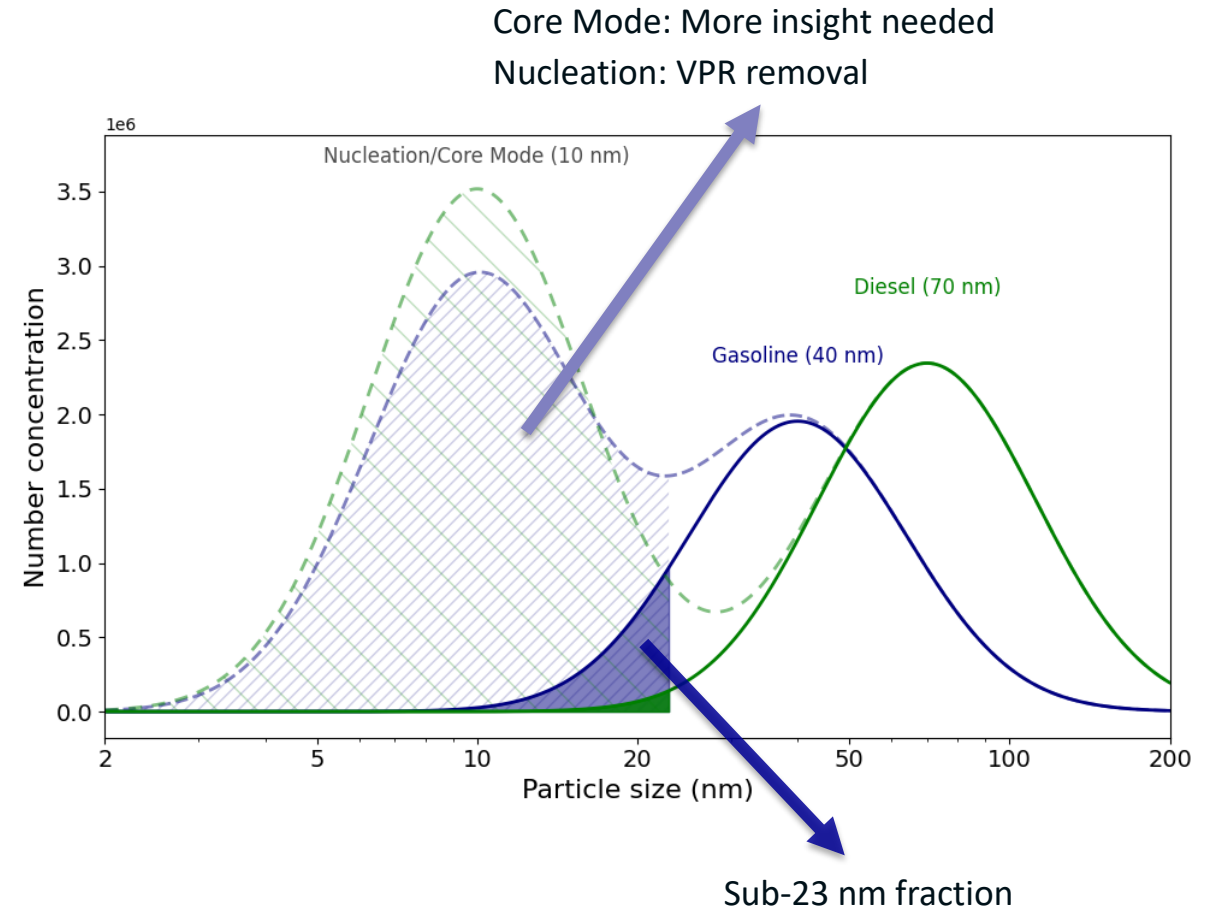


Gasoline PTI – Particle Size

- Gasoline exhaust contains smaller particles
 - ~ 40 nm vs ~ 70 nm (diesel) during drive cycles in accumulation mode
 - Gasolines: Smaller GMD → Increased sub-23 nm fraction

Bimodal distributions can occur:

- Volatiles: Nucleation mode removed via VPR
- Solid particles: Core mode often has high metallic contents, often attributed to oil additives or ash [4]



[4] Guo et al, <https://doi.org/10.3390/atmos13081216>

Gasoline PTI – Particle Size

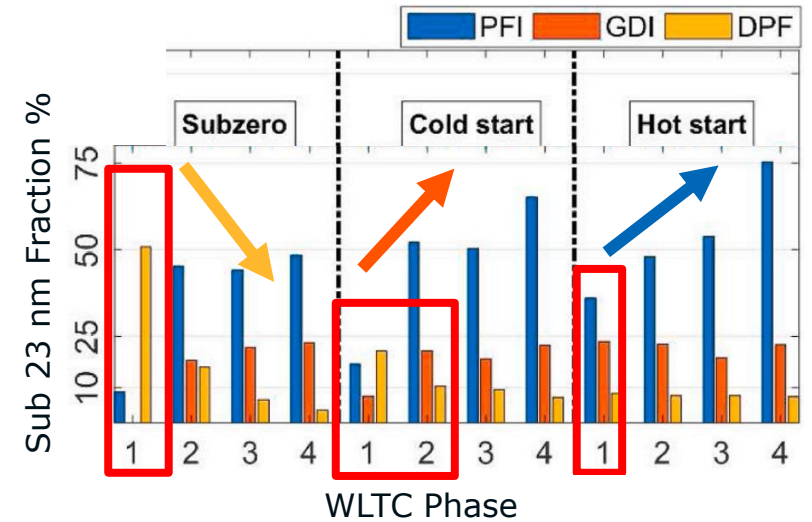
- **Sub-23 nm mode** can vary strongly:
 - Engine temperature and load state
 - Environmental conditions
 - Combustion system → gasoline and diesel diverge

→ How does the size distribution of gasolines look during idle measurement in PTI?

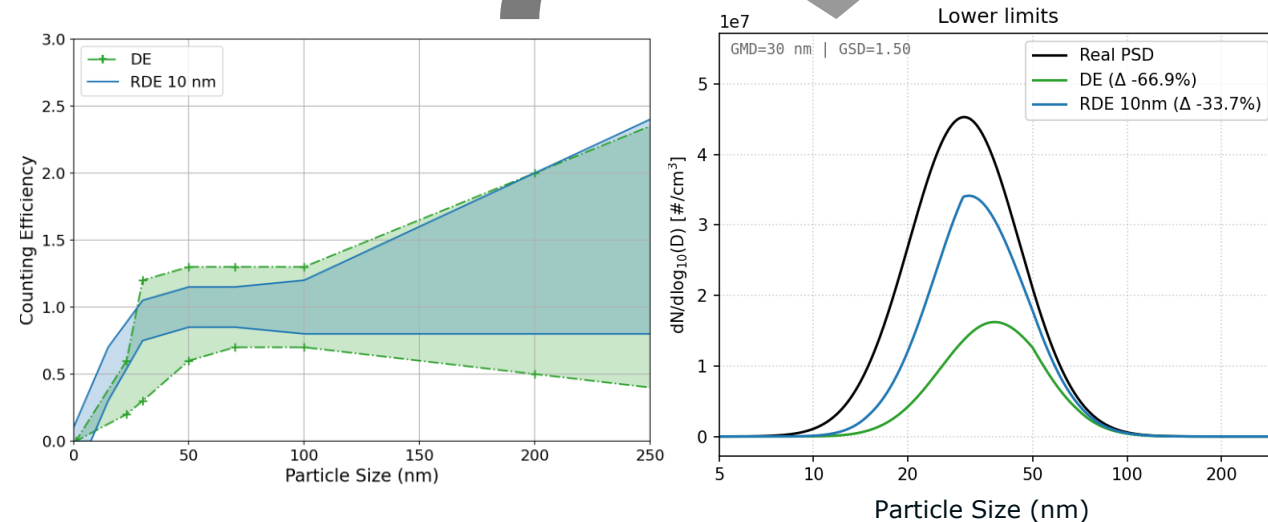
- Lack of relevant size distributions data in literature

→ What are subsequent implications for a reduced 10 nm cut-off size limit on the detection efficiency?

- Simulation tool to calculate false-pass, false fail cases
- Input Parameters for GUI: Particle size distribution, counting efficiency limits and limit PN values

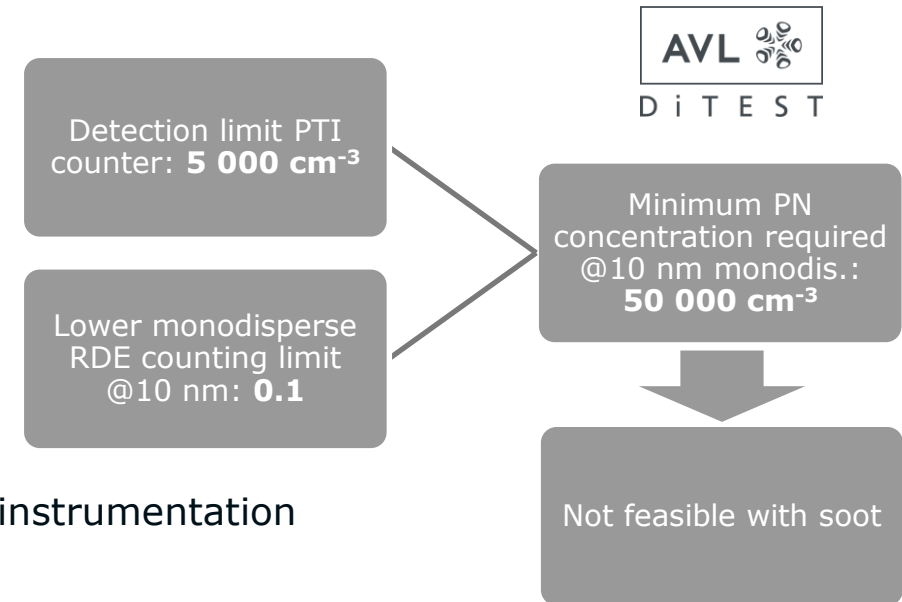


[4] Lähde et al., <https://doi.org/10.1016/j.jaerosci.2021.105873>



10 nm Roadblocks and Outlook

- 10 nm PTI limit would introduce additional costs
 - Metrological and Regulatory Barriers
 - Insufficient generation of representative calibration aerosol at 10 nm
 - New calibration procedure needs to be defined with alternative test aerosol
 - Higher diffusional losses in instrumentation → mitigation requires costly instrumentation
 - Increased complexity and instrumentation requirements
- First gasoline PN limit introduced with Euro 6b; 10 nm limit applies only for Euro 7
 - Focus: GPF failure detection independent of 23 nm or 10 nm limit for homologation



Metrological and regulatory hurdles for 10 nm measurement delay implementation and increase cost

→ **Use established 23 nm PTI counters for gasoline PN measurement and avoid Sub-23 nm**

→ **Focus on developing a reliable procedure and limit value to minimize false fail and false pass events**

Thank you



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